METEOROLOGICAL

QUALITY ASSURANCE PROJECT PLAN

VOLUME III

B-003-OAQ-AMB-QA-20-Q-R0

PREPARED BY:

Indiana Department of Environmental Management (IDEM)
Office of Air Quality (OAQ)
Air Monitoring Branch (AMB)
Quality Assurance Section (QAS)
Mail Code 61-54-2
100 N. Senate Avenue
Indianapolis, IN 46204-2251

Revision 0

January 1, 2020

QAPP Revision History

Revision Number	Date	Responsible Party	Description of Change
0	January 1, 2020	QAS Chief	New QAPP format to replace QA Manual, which served as OAQ AMB QAPP, and was last U.S. EPA approved on March 9, 2018.

List of Acronyms

Acronym	Meaning
°C	Degrees Celsius
AA	Administrative Assistant
AC	Assistant Commissioner
AMB	Air Monitoring Branch
AMS	Ambient Monitoring Section
ANP	Annual Network Plan
AQI	Air Quality Index
AQS	Air Quality System
ATS	Air Toxics Section
BP	Barometric Pressure
CAA	Clean Air Act
CBSA	Core Based Statistical Area
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CSN	Chemical Speciation Network
CTS	Collocated Transfer System
DP	Dew Point
EPA	Environmental Protection Agency
GCMS	Gas Chromatography Mass Spectrometry
GD	Guidance Documents
RH	Relative Humidity
IDEM	Indiana Department of Environmental Management
INDOT	Indiana Department of Transportation
IMPROVE	Interagency Monitoring of Protected Visual Environments Network
K	Kelvin; 0 Kelvin is -273.15 °C
LEADS	Leading Environmental Analysis and Display System
MLH	Mixing Layer Height
MWG	Maximum Wind Gust
NAAQS	National Ambient Air Quality Standards
NCore	National Core Network
NIST	National Institute of Standards and Technology
NO	Nitric Oxide

Acronym	Meaning
NO_2	Nitrogen Dioxide
NO_y	Reactive Nitrogen Compounds
O_3	Ozone
OAQ	Office of Air Quality
OPS	Office of Program Support
OT	Outdoor Temperature
P	Precipitation
PAMS	Photochemical Assessment Monitoring Station
Pb	Lead
PE	Performance Evaluation
PM	Particulate Matter
$PM_{1.0}$	Particulate matter having an aerodynamic diameter less than or equal to 1.0 um
$PM_{2.5}$	Particulate matter having an aerodynamic diameter less than or equal to 2.5 um
PM_{10}	Particulate matter having an aerodynamic diameter less than or equal to 10 um
PM_{10c}	Particulate matter having an aerodynamic diameter between 2.5 um and 10 um
PQAO	Primary Quality Assurance Organization
PSD	Prevention of Significant Deterioration
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QAS	Quality Assurance Section
QC	Quality Control
QMP	Quality Management Plan
REQAS	Recycling, Education and Quality Assurance Section
RH	Relative Humidity
RPM	Revolutions per Minute
RTD	Resistance Temperature Detector
RWD	Resultant Wind Direction
RWS	Resultant Wind Speed
SDHD	Standard Deviation of Horizontal Wind Direction
SIP	State Implementation Plan
SLAMS	State and Local Air Monitoring Stations
SO_2	Sulfur Dioxide
SPM	Special Purpose Monitoring
SOP	Standard Operating Procedure
SR	Solar Radiation
STN	Special Trends Network
T	Temperature
TAD	Technical Assistance Documents
TSOP	Technical Standard Operating Procedure
UVC	Ultraviolet Carbon

Acronym	Meaning
UVR	Ultraviolet Radiation
VFC	Virtual File Cabinet
VOC	Volatile Organic Compound
VWD	Vertical Wind Direction
WS	Wind Speed

Section 1: Quality Assurance Project Plan (QAPP) Identification and Approval

Indiana Department of Environmental Management (IDEM) – Office Air Quality (OAQ) – Air Monitoring Branch (AMB) – Quality Assurance Project Plan (QAPP) – Meteorological – Revision 0

This QAPP is designed to provide an overview of the minimum requirements for a quality assurance (QA) and quality control (QC) program for air monitoring networks which conduct meteorological monitoring in the state of Indiana. Requiring monitoring networks to meet these criteria allows the data from all monitoring networks to be consistent, scientifically defensible and comparable. Meteorological monitoring consists of:

- Wind speed (WS)
- Resultant wind speed (RWS)
- Resultant wind direction (RWD)
- Maximum wind gust (MWG)
- Standard deviation of horizontal wind direction (SDHD)
- Vertical wind direction (VWD)
- Outdoor temperature (OT)
- Dew point (DP)
- Relative humidity (RH)
- Barometric pressure (BP)
- Precipitation (P)
- Solar radiation (SR)
- Ultraviolet radiation (UVR)
- Mixing layer height (MLH)

A QC/QA program encompasses all phases of ambient air sampling and data analysis. These phases include such activities as site selection, monitoring equipment selection, calibration/verification/audit equipment and procedures, sampling procedures, laboratory analysis, data verification/validation, chain of custody, data reporting, precision/accuracy reporting, and meteorological criteria. Prior to the implementation of any ambient monitoring network becoming operational, a working knowledge of this QAPP is necessary by those personnel designated as QC and QA.

There are three basic sections of the CFR Title 40, Protection of the Environment, which deal with Ambient Air Monitoring. 40 CFR Part 50 lists the National Primary and Secondary Ambient Air Quality Standards. 40 CFR Part 53 lists alternate equivalent air monitoring methods and procedures for obtaining equivalency. Finally, 40 CFR Part 58 gives detailed descriptions of monitoring methodology, network design and siting, Prevention of Significant Deterioration

(PSD) requirements, and QA criteria. Additional federal requirements are also given in U.S. Environmental Protection Agency (EPA) Technical Assistance Documents (TAD) and U.S. EPA QA Guidance Documents (GD). Designated QC and QA personnel should maintain a working knowledge of all applicable requirements. All monitoring and QA program requirements must be kept current and accessible.

Document Approval

Meteorological Quality Assurance Project Plan Volume III

Indiana Department of Environmental Management
Office of Air Quality
Air Monitoring Branch
Indianapolis, IN 46219

B-003-OAQ-AMB-QA-20-Q-R0

Approval Signatures and Date Signed:

IDEM AMB Chief	**Signature:** ______________________________	**Date:** ____________
IDEM AMB AMS 1 Chief	**Signature:** ______________________________	**Date:** ____________
IDEM AMB AMS 2 Chief	**Signature:** ______________________________	**Date:** ____________
IDEM AMB ATS Chief	**Signature:** ______________________________	**Date:** ____________
IDEM AMB QAS Chief	**Signature:** ______________________________	**Date:** ____________
IDEM OAQ Assistant Commissioner	**Signature:** ______________________________	**Date:** ____________
IDEM OPS QA Staff	**Signature:** ______________________________	**Date:** ____________
U.S. EPA Region 5 QA Coordinator	**Signature:** ______________________________	**Date:** ____________

Section 2: Table of Contents

List of Tables and Figures

Section 3: Distribution / Notification List

All members of the IDEM/OAQ play an important role in the collection, validation, data analysis, assessment, planning, and reporting of air monitoring data. All entities that are part of the primary quality assurance organization (PQAO) are provided electronic copies of this QAPP and must adhere to the elements of the QAPP. Copies of the QAPP are also provided to those who conduct air monitoring in Indiana under their own PQAO. Table 1 shows how the QAPP is distributed. An official copy of the QAPP is also available on the IDEM air quality web page and the IDEM SharePoint™ QA Library.

Table 1. QAPP Distribution

Name	Organization	Phone
Air Monitoring Branch Chief	IDEM/OAQ/AMB	317-308-3264
Quality Assurance Section Chief and Staff	IDEM/OAQ/AMB/QAS	317-308-3257
Ambient Monitoring Section (1 and 2) Chief(s) and Staff	IDEM/OAQ/AMB/AMS(s)	AMS#1 317-308-3263 AMS#2 317-308-3272
Air Toxics Section Chief and Staff	IDEM/OAQ/AMB/ATS	317-308-3248
Office of Program Support Recycling, Education and Quality Assurance Section Chief	IDEM/OPS/REQAS	317-234-6562
Environmental Coordinator	Industries conducting air monitoring in Indiana	Contact QAS Chief
Environmental Coordinator	Consultants conducting air monitoring in Indiana	Contact QAS Chief
QA Manager	U.S. EPA Region 5	312-353-2325
IDEM Quality Management Staff	IDEM Office of Program Support	Contact OPS REQAS Chief

Section 4: Project/Task Organization

4.1 Personnel Roles and Responsibilities in IDEM

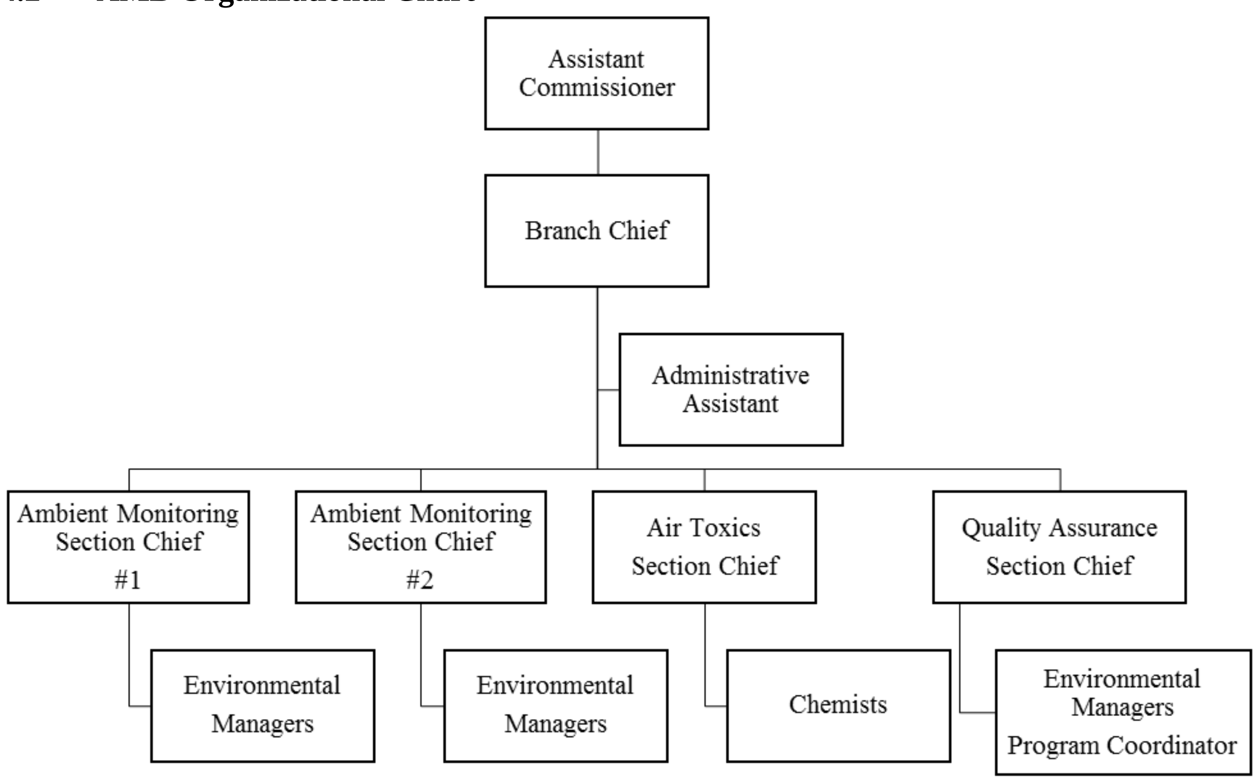
Key functions and responsibilities in IDEM are:

1. OAQ program management: Assistant Commissioner
2. AMB management: AMB Chief; AMS (1 and 2) Chief(s); ATS Chief; QAS Chief
3. Initiate equipment and supplies request: AMS (1 and 2) Environmental Managers, QAS Environmental Managers, and ATS Chemists with oversight by AMS (1 and 2) Chief(s), QAS Chief, and ATS Chief.
4. Procurement of AMB equipment and supplies: final approval by AMB Chief; tracking by AA
5. Air monitoring site selection, maintenance, and operation which includes calibrations,

verifications, span, zero, and QC checks: AMS Environmental Managers and ATS Chemists with oversight by AMS (1 and 2) Chief(s) and ATS Chief. As needed assistance for site selection and parameters by OAQ Programs Branch

6. Air monitoring data handling, review, verification, and retrieval requests: AMS Environmental Managers and ATS Chemists with oversight by AMS (1 and 2) Chief(s) and ATS Chief
7. Air monitoring network review and project grants: AMB Chief; AMS (1 and 2) Chief(s)
8. QA performance and system audits, site evaluations, and data validation: QAS Environmental Managers and Program Coordinator with oversight by QAS Chief
9. QA laboratory: Designated QAS Environmental Manager oversees most of the work performed in the QA laboratory with some assistance from other QAS Environmental Managers and oversight by QAS Section Chief
10. QMP development/updates, QAPP/TSOP/SOP approval; TSOP/SOP agency distribution; review, authorization, and management of QA documentation (part 5 of QMP discusses documents and records): OPS
11. Programs Branch, Permits Branch, and Compliance and Enforcement Branch: utilize AMB data; see https://www.in.gov/idem/airquality/ for specific duties of these areas

4.2 AMB Organizational Chart



4.3 AMB Roles and Responsibilities

Table 2 lists general duties of the positions within the AMB. The AMS #2 has an Environmental Manager designated as the AQS administrator, whose responsibilities include data submittal into AQS. Also in the AMS #2 is an Environmental Manager designated as the LEADS administrator, whose duties include reviewing and evaluating data outputs as well as setting limits, overseeing programming within LEADS, and coordinating specific work functions of LEADS with the LEADS contractor. The environmental managers/program coordinator listed under the QAS maintain separate equipment from the AMS(s) and the ATS which ensures that an independent QA program is maintained. However, on occasion the QAS equipment may be used for a QC check but never to calibrate the site instruments. Data is also validated by the QAS once it has been verified by the AMS(s) and the ATS. The QAS maintains the QAPP(s) and has final decision on data validity.

Table 2. Duties of Air Monitoring Branch Positions

Position	**Duties**
Air Monitoring Branch Chief	Overall program management; supervises section chiefs and AA; approves the purchase of major equipment; approves QAPPs/TSOPs/SOPs; and approves annual certification of data.
Ambient Monitoring Section Chiefs	Approves and makes sure AMS staff adhere to the QAPPs/TSOPs/SOPs; oversight and direction of all ambient monitoring functions which includes calibrations, verifications, QC checks, data analysis, site location/setup/shutdown, site maintenance, and the development/update of the ANP/5-year network assessment; ensures data meets quality standards; approves annual certification of data; and supervises AMS staff.
Air Toxics Section Chief	Approves and makes sure ATS staff adhere to the QAPPs/TSOPs/SOPs; oversight and direction of all toxic functions which include laboratory and field GCMS; instrument calibration and sample analysis; ensures data meets QC standards; provides assistance for the update of the ANP/5-year network assessment; approves annual certification of data; and supervises ATS staff.
Quality Assurance Section Chief	Responsible for the creation, maintenance, revisions, and adherence to the QAPPs/TSOPs/SOPs; oversight and direction of all QA functions which include PE/systems audits, meteorological audits, toxic audits, site evaluations, and operation of the QA laboratory; ensures data meets quality standards with authority to make final decision on data validity; approves annual certification of data; and supervises QAS staff.

Position	Duties
Ambient Monitoring Environmental Managers	Performs the daily operations that are required for the air monitoring data to be properly collected, analyzed, and verified; performs site/equipment location/setup/maintenance/shutdown and calibrations/verifications/QC checks on air monitoring field equipment; and reviews, writes, and updates TSOPs/SOPs.
Air Toxics Chemists	Performs the daily operations that are required for the air monitoring data to be properly collected, analyzed, and verified; perform site visits to conduct maintenance on air toxics monitoring equipment; and reviews, writes, and updates TSOPs/SOPs.
Quality Assurance Environmental Managers	Performs PE/systems audits, meteorological audits, toxic audits, and site evaluations; performs maintenance and calibration/certification/verification on equipment; validates data; reviews, writes, and updates QAPPs/TSOPs/SOPs; and will track the completion of corrective actions and determine the success of these actions.
Quality Assurance Program Coordinator	Assists with meteorological audits and site evaluations; distributes, tracks, and validates data; performs audits on the PM clean rooms; reviews, writes, updates; and distributes QAPP/TSOPs/SOPs; communicates QA work to AMB Chief for bi-weekly report, which includes TSOP/SOP approval/revision updates; and will track the completion of corrective actions and determine the success of these actions.
Air Monitoring Branch Administrative Assistant	Organizes the tracking and surplus of air monitoring equipment and maintains the QA documentation used to implement that monitoring program.

Section 5: Problem Definition/Background

In 1970, the Clean Air Act (CAA) was signed into law. The CAA provided the regulations and framework for the monitoring of criteria pollutants (CO, NO_2, O_3, SO_2, Pb, PM) by state, local, and tribal organizations through the establishment of an Air Quality Monitoring Program.

IDEM's mission is to implement federal and state regulations to protect human health and the environment while allowing the environmentally sound operations of industrial, agricultural, commercial and government activities vital to a prosperous economy. The mission of the OAQ is to assure all Hoosiers ambient air quality meets the NAAQS; provide timely, quality air permits without unnecessary requirements; and to verify compliance with applicable state and federal air pollution laws and regulations. Five branches are part of the OAQ, which includes Programs, Permits, Compliance and Enforcement, Operations, and Air Monitoring. A description and a flowchart of these is available in the QMP at https://extranet.idem.in.gov/standards/docs/quality_improvement/qmps/idem_qmp_2018.pdf. The AMB is divided among four sections (See 4.2. AMB Organizational Chart, above) which includes two site monitoring sections (AMS's), an air toxics laboratory (ATS), and a quality assurance section (QAS).

This QAPP covers all of the meteorological parameters, as stated in Section 1. The QAPP is reviewed annually and updated if needed. Any TSOPs/SOPs associated with this QAPP are updated a minimum of every four years or if the procedures change. Meteorological data is collected to:

- Support for pollutant data that is monitored to provide evidence NAAQS is being met
- Use in modeling applications implemented by OAQ Programs Branch which help develop, modify, or activate control strategies that prevent or reduce air pollution episodes
- Determine how weather patterns affect pollution trends throughout the state and/or region

Section 6: Project/Task Description

Meteorological data is collected since it can influence the impact of the pollutants. Data collection has been going on for decades. Some of the meteorological data collection is required for specific sites, based on network description. The U.S. EPA provides information on which networks are required to collect specific meteorological data. The National Weather Service may provide meteorological data as well; however, there are instances where it benefits to know the atmospheric condition at the location where the pollutant data is collected. Also, meteorological data generated from the AMB may be more suited for the studies since it is of known accuracy, has specific siting criteria, and there is consistency from site to site.

6.1 Overview of Monitored Meteorological Parameters

IDEM presents two different types of air quality data, intermittent and continuous, on IDEM's internet website http://www.in.gov/idem/airquality/2346.htm. Monthly and annual summary reports of pollutants collected by manual methods are available as well as hourly values from continuous monitors. The LEADS provides on-line access to Indiana's continuous air quality monitoring network. It has been available to the public since July, 2007. LEADS offers access to near real-time data from approximately 60 active and historic data from approximately 12 discontinued continuous air monitoring sites across Indiana. This allows anyone to track pollutant and meteorological values throughout the day. In addition, past data back to 1998 are available as raw data and canned summary reports or user specified retrievals. Also available on LEADS is intermittent data from approximately 45 sites. Below are the different meteorological parameters which are monitored.

Collected Meteorological Parameters

Wind Speed (WS)

Wind speed is measured directly in miles per hour with either an ultrasonic wind unit or a propeller wind unit. Wind speed values are the average of the 5-minute wind speeds for each hour. This average is calculated by adding all the 5-minute wind speed averages measured in one hour and dividing by the number of measurements. Wind speed is collected since it can affect the dispersal and dilution of pollutants.

Wind Direction (WD)

Wind direction is measured directly with either an ultrasonic wind unit or a propeller wind unit. Although wind direction is measured, it is not reported as is. The values collected are used to calculate resultant wind speed, resultant wind direction, and standard deviation of horizontal wind direction. Wind direction is collected since it can help determine where the pollutant came from and the transport direction.

Vertical Wind Direction (VWD)

Vertical wind direction is the angle that the wind is moving using a 3-dimensial ultrasonic wind unit. A positive degree means the wind is moving in an upward angle while a negative degree means the wind is moving in a downward angle. Knowing the vertical angle of the wind can help determine how much pollution in the atmosphere is being dispersed.

Maximum Wind Gust (MWG)

Maximum wind gust is measured in miles per hour with either an ultrasonic wind unit or a propeller wind unit. The maximum wind gust is the peak wind speed observed over a number of seconds during the hour. Knowing the maximum wind gust can give a good indication of atmospheric stability and the ability of pollutants to be dispersed.

Outdoor Temperature (OT)

Outdoor temperature is measured in degrees Fahrenheit using a platinum RTD temperature probe. This is the temperature of the air outside the monitoring site. Outdoor temperature is measured to determine the amount of rise experienced by a buoyant plume. Outdoor temperature also plays a role in chemical processes of air pollutants.

Relative Humidity (RH)

Relative humidity is measured in percent relative humidity using a Vaisala intercap hygrometer probe. Relative humidity is a measure of the moisture present in the air expressed in percent. One-hundred percent relative humidity is totally saturated air. Humidity is the amount of moisture in the air. Using relative humidity along with temperature and pressure can provide a good indication of chemical reactions of air pollutants.

Barometric Pressure (BP)

Barometric pressure is measured in millibars using a pressure sensor. Barometric pressure is the force per unit area (pressure) exerted by the atmosphere as a consequence of gravitational attraction exerted upon the "column" of air lying directly above a specific point. Knowing the barometric pressure can help determine whether pollution levels build up. When the barometric pressure is high, the air is usually still which allows pollution levels to build up. When the barometric pressure is low, the weather is often wet and windy, causing pollution to be dispersed or washed out of the atmosphere by precipitation.

Precipitation (P)

Precipitation is measured in inches (rainfall) using a tipping bucket rain gauge. Precipitation is any form of water (liquid or solid) that falls from a cloud and reaches the ground. Precipitation can reduce pollution levels in the atmosphere, such as O3 and PM, so knowing if a precipitation event occurred can help determine why pollution levels in the atmosphere decreased.

Solar Radiation (SR)

Solar radiation is measured in Langleys per minute using a pyranometer. Solar radiation is the total electromagnetic radiation emitted by the sun which is received at the air monitoring site. Knowing the amount of solar radiation can help in determining photochemical processes of air pollutants in the atmosphere as well as turbulence.

Ultraviolet Radiation (UVR)

Ultraviolet radiation is measured in millicalories per square centimeter per minute using a radiometer. Knowing the amount of ultraviolet radiation can help in determining photochemical processes of air pollutants in the atmosphere as well as turbulence.

Mixing Layer Height (MLH)

Mixing layer height is measured using a ceilometer. Measuring the mixing layer height helps determine the volume of air into which pollutants and their precursors are emitted, thus impacting near-surface atmospheric pollutant concentrations.

Calculated Meteorological Parameters

Resultant Wind Speed (RWS)

Resultant wind speed is measured in miles per hour. Resultant wind speed values are obtained by converting the 5-minute wind speeds and directions for the hour into a single hourly vector. Resultant wind speed is the magnitude of this vector.

Resultant Wind Direction (RWD)

Resultant wind direction is measured in degrees compass. Resultant wind direction values are obtained by converting the 5-minute wind speeds and directions for the hour into a single hourly vector. Resultant wind direction is the direction of this vector. Wind direction, the direction from which the wind is blowing, is measured to the nearest degree based on a 360 degree compass with 360 degrees being from the North and 180 degrees being from the South. Zero degrees indicates no wind speed was detected for that time frame (calm conditions).

Standard Deviation of Horizontal Wind Direction (SDHD)

Standard deviation of horizontal wind direction is measured in degrees compass. Standard deviation of horizontal wind direction is a measure of the variability of the direction from which the wind is blowing. Zero standard deviation means that there is no variability in the wind direction. A high standard deviation indicates a large variation in the direction from which the wind is blowing.

Dew Point (DP)

Dew point temperature is measured in degrees Fahrenheit. Dew point temperature values represent the temperature at which the ambient air would become saturated; i.e., dew will form. The dew point can be used to predict the formation of dew, frost, fog, etc. Dew point is calculated by using the outdoor temperature and the relative humidity.

6.2 Project Schedule

The AMB collects and analyzes meteorological data to assist in determining sources of air pollution and predict pollutant episodes. Checks on the equipment are performed. Tables 3, 4, and 5 list information outlining the collection and checks of the various types of meteorological data. Specific information relating to this work are outlined in the AMB TSOPs “RM Young 05305-AQ Wind Direction/Wind Speed Calibration/Maintenance”, “RM Young 41372VF Outdoor Temperature/Relative Humidity Calibration/Maintenance”, “Barometric Pressure Calibration/Maintenance”, “RM Young 52202E Precipitation Calibration/Maintenance”, “Eppley Precision Spectral Pyranometer Calibration/Maintenance”, “Eppley Total Ultraviolet Radiometer Calibration/Maintenance”, “RM Young 86004 Ultrasonic Anemometer Audit”, “RM Young 05305-AQ Wind Direction Audit”, “RM Young 05305-AQ Wind Speed Audit”, “RM Young 41372VF Outdoor Temperature Audit”, “RM Young 41372VF Relative Humidity Audit”, “RM Young/Met One Barometric Pressure Sensor Audit Procedures”, “Audit Method for Precipitation Gauge Measurement”, and “Precision Spectral Pyranometer and Total Ultraviolet Radiometer Collocated Audit”.

Table 3. Meteorological Data Collection Frequency

Parameter	**Sample Frequency**
WS	Continuous
RWS	Calculated hourly from continuous WS and WD
RWD	Calculated hourly from continuous WS and WD
MWG	Continuous
SDHD	Calculated from continuous WD
VWD	Continuous
OT	Continuous
DP	Calculated from continuous OT and RH
RH	Continuous
BP	Continuous
P	Continuous
SR	Continuous
UVR	Continuous
MLH	Continuous

Table 4. AMS Verification/Calibration on Meteorological Equipment

Parameter	Frequency
WS	Annual
WD	Annual
OT	NCORE/PAMS (6 months); SLAMS (Annual)
RH	NCORE/PAMS (6 months); SLAMS (Annual)
BP	NCORE/PAMS (6 months); SLAMS (Annual)
P	NCORE/PAMS (6 months); SLAMS (Annual)
SR	Bi-annual
UVR	Bi-annual
MLH	Annual

Table 5. QAS PE Audit on Meteorological Equipment

Parameter	Frequency
WS	NCORE/PAMS (6 months); SLAMS (Annual)
WD	NCORE/PAMS (6 months); SLAMS (Annual)
OT	Annual
RH	Annual
BP	Annual
P	6 months
SR	6 months
UVR	6 months
MLH	Annual

6.3 Site Locations

Site locations are available in the IDEM/OAQ/AMB Annual Network Plan and through http://idem.tx.sutron.com/. The locations and meteorological parameters measured will depend on the type of monitoring network. Listed below are the different air monitoring networks where meteorological parameters are collected.

State and Local Air Monitoring Stations (SLAMS)

SLAMS consists of a national network of monitoring sites whose size and distribution is largely determined by the needs of state and/or local air pollution authorities.

Special Purpose Monitoring (SPM)

SPM are designed/intended for use by state and local agencies to collect supportive data for development of SIPs and/or other specific targeted studies such as: point source identification, control strategy effectiveness, etc. If data is used for SIP purposes, SPM sites must meet all federal and state requirements for monitoring methodology and quality assurance.

National Core Network/Photochemical Assessment Monitoring Station (NCore/PAMS) Monitoring

NCore is a multi-pollutant approach to monitoring. NCore sites are intended to support multiple objectives with a greater emphasis on assessment, research support, and accountability than the traditional SLAMS networks. NCore provides an opportunity to address new directions in monitoring and begin to fill measurement and technological gaps that have accumulated in the networks. Indiana operates one urban NCore site. These sites are required to measure $PM_{2.5}$, speciated $PM_{2.5}$, PM_{10c}, O_3, SO_2, CO, NO, true NO_2, NO_y, and meteorology. As of June 2019 PAMS is included at NCore sites located in a CBSA with a population of 1,000,000 or more.

Near-Road Monitoring

On February 9, 2010, the U.S. EPA promulgated monitoring regulations for the NO_2 monitoring network. In the new monitoring requirements, state and local air monitoring agencies are required to install near-road NO_2 monitoring stations at locations where peak hourly NO_2 concentrations are expected to occur within the near-road environment in larger urban areas. Site selection is required to consider traffic volumes, fleet mix, roadway design, traffic congestion patterns, local terrain, and meteorology in determining where a required near-road NO_2 monitor should be placed. Indiana operates one near-road monitoring site. IDEM worked with the INDOT to obtain a location for the site. The near-road site is required to measure NO, NO_2, CO, O_3, and meteorology. Toxics VOC's and particulates, such as $PM_{2.5}$, $PM_{1.0}$, and continuous speciation (black carbon/UVC) are also measured at this site.

Chemical Speciation Network (CSN)

As part of the $PM_{2.5}$ NAAQS review completed in 1997, EPA established a $PM_{2.5}$ CSN consisting of STN sites and supplemental speciation sites. The CSN is a component of the National $PM_{2.5}$ Monitoring Network. The goal of the National $PM_{2.5}$ Monitoring Network is to monitor if the NAAQS are being attained. However, CSN data is not used for attainment or nonattainment decisions, but are intended to complement the activities of the larger gravimetric $PM_{2.5}$ measurement network component. CSN data is used for multiple objectives, including:

- The assessment of data trends;
- The development of effective SIPs and determination of regulatory compliance;
- The development of emission control strategies and tracking progress of control programs;
- Aiding in the interpretation of health studies by linking effects to $PM_{2.5}$ constituents;
- Characterizing annual and seasonal spatial variation of aerosols; and
- Comparison to chemical speciation data collected from IMPROVE network.

Section 7: Quality Objectives and Criteria for Measurement Data

The primary data quality objective is to ensure that the data collected by the AMB are consistent, of known and adequate quality, supported by adequate calibrations and evaluations, and sufficiently complete to describe the atmospheric state with respect to spatial and temporal distribution. Although no minimum QA requirements are listed in the CFR, the data collected must be shown to be accurate and represent the actual conditions. To determine if the data is accurate, measurement quality objectives based on U.S. EPA document "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements", the U.S. EPA QAPP "PAMS Required Site Network for Speciated Volatile Organic Compounds, Carbonyls, and Meteorological Parameters Including Mixing Layer Height", as well as manufacturer recommendations are adopted.

Collecting quality data begins with properly trained staff and adequate funding to provide the necessary equipment that meets required performance specifications. High quality data also relies on having adequate supplies available, safe monitoring locations that meet U.S. EPA siting requirements, up-to-date QAPP(s), and TSOPs/SOPs.

7.1 Measurement Quality Objectives

To ensure the quality of the data, calibrations and verifications are performed by the AMS. For some instrumentation this may require sending the unit back to the manufacturer or some other certification facility which can perform the calibration. Verifications are performed by AMS either when the unit may not be working accurately or prior to adjusting or swapping out a unit. These checks help determine the validity of the data by ensuring that the units meet specific limits. Additional PE audits are performed independently by the QAS. The QA results assist with ensuring the unit is working within specifications and can solidify the site operator’s decision on the condition of the data. Tables 6 and 7 list the types of checks as well as limits for each type of meteorological equipment. Calculations are provided in AMB TSOPs listed in section 6.2 of this QAPP.

Table 6. AMS Meteorological Methods Data Assessment Requirements

Type of Check: Calibration and Verification		
Parameter Method	**Assessment Method**	**Measured Quality Objectives**
WS	Propeller unit: Check of mph against synchronous motor at minimum of 2 speeds (one within 10 mph and one greater than 20 mph) and a zero check; Ultrasonic unit: factory check	Propeller unit: WS <±0.55 mph up to 10.0 mph check, <±5.1% for speeds greater than 10.0 mph, and zero = 0.0; Ultrasonic sent to factory for wind tunnel check and calibration
WD	Propeller unit: Check against to and from reference point and 360 degree linearity check; Ultrasonic unit: factory check	Propeller unit: WD <±5.1 degrees difference shooting reference point and <10.1 degrees linearity spread; Ultrasonic sent to factory for wind tunnel check and calibration
VWD	Factory check	Ultrasonic sent to factory for wind tunnel check and calibration
OT	Check against temperature transfer standard at approximately 45 °C, 20 °C, 0 °C, and -20 °C	OT <±1.1 °C for SLAMS sites; OT <±0.55 °C for NCORE/PAMS sites

Parameter Method	**Assessment Method**	**Measured Quality Objectives**
RH	Check against RH transfer standard at approximately 85%RH, 60%RH, 35%RH, and air check	%RH <±10.1 %RH at SLAMS sites; %RH <±5.1 %RH at NCORE/PAMS sites
BP	Check against BP transfer standard 2 times (e.g. arrival at site and prior to departure)	BP <±3.1 millibars at SLAMS sites; BP <±1.1 millibars at NCORE/PAMS sites
SR	Factory check	Unit sent to factory for check and calibration
UVR	Factory check	Unit sent to factory for check and calibration
P	Check against 3 known amounts of water at approximately 0.295 inches, 0.590 inches, and 0.885 inches	Precipitation<±10.1%
MLH	Check against target placed at a fixed known distance	≤±5.0 meters or ±1.0%, whichever is greater

Table 7. QAS Meteorological Methods Data Assessment Requirements

Type of Check: PE Audit		
Parameter Method	**Assessment Method**	**Measured Quality Objectives**
WS	Propeller unit: Check of mph against synchronous motor at 4 speeds (approximately 4.58, 11.45, 22.90, and 80.15 mph) and a zero check; Ultrasonic unit: collocated check	Propeller WS <±0.55 mph up to 10.0 mph check, <±5.1% for speeds greater than 10.0 mph, and zero = 0.0; QAS propeller unit collocated with site ultrasonic (see Table 8)
WD	Propeller unit: Check against to and from reference point and 360 degree linearity check; Ultrasonic unit: collocated check	Propeller WD <±5.1 degrees difference shooting reference point and <10.1 degrees linearity spread for bench test; QAS propeller unit collocated with site ultrasonic (see Table 8)
VWD	Collocated check	QAS ultrasonic wind unit collocated with site ultrasonic (see Table 8)
OT	Check against temperature transfer standard at approximately 45 °C, 20 °C, 0 °C, and -20 °C	OT <±1.1 °C for SLAMS sites; OT <±0.55 °C for NCORE/PAMS sites

Parameter Method	Assessment Method	Measured Quality Objectives
RH	Check against RH transfer standard at approximately 85%RH, 35%RH, and air check	%RH <±10.1 %RH at SLAMS sites; %RH <±5.1 %RH at NCORE/PAMS sites
BP	Check against BP transfer standard 2 times (e.g. arrival at site and prior to departure)	BP <±3.1 millibars at SLAMS sites; BP <±1.1 millibars at NCORE/PAMS sites
SR	Collocated check	SR <±5.1% for daylight values; nighttime values should be 0 (see 7.2.2)
UVR	Collocated check	UV <±5.1% for daylight values; nighttime values should be 0 (see 7.2.2)
P	Check against 2 known amounts of water, one check < 1 inch and check > 1 inch	Precipitation <±10.1%
MLH	Check against target placed at a fixed known distance	≤±5 meters or ±1%, whichever is greater

7.2 Collocated Transfer System (CTS) Method

For sites which collect wind data with an ultrasonic wind unit and radiation with a pyranometer and ultraviolet radiometer, using a transfer standard to challenge these units with known values is not possible. Audits on these systems are performed using a CTS method.

7.2.1 Wind CTS Audit

At sites which have an ultrasonic wind unit, the QAS will set up a propeller unit for approximately one week to audit the wind speed, resultant wind speed, and the resultant wind direction. The propeller unit's accuracy is confirmed prior to the collocated audit by auditing the shaft rotation speed with several known rotation speeds (RPM) and confirming the wind direction passes the bench linearity test. The wind speed limits are described in Table 7 of this QAPP and the bench linearity limit is five degrees. For ultrasonic units that measure vertical wind direction, a factory calibrated QA wind unit of the same make and model that is at the site is installed for approximately one week.

Once installed the QA wind unit is aligned within three degrees of a known reference point. The degrees of the reference point is determined by using the solar azimuth or a compass. Once the QA unit is picked up, the data is collected and compared. The comparison is based on taking the mean of all the hourly differences during the test period. The limits are listed in Table 8. Failure to meet the limits will result in screening the data for potential outliers, resolve potential issues with the field or the QA unit, and overall review of data collected at the site, before, during, and after the audit. Any issues with the results may require a QA qualifier or null data qualifier be applied to the data, the field unit needing maintenance/calibration, or additional audit checks.

Table 8: Collocated Wind Audit Limits

Parameter	Average Difference	Standard Deviation of difference
WS	± 0.55923 mph < 11.185 mph ± 5.592 mph > 11.185 mph	0.4474 mph
WD	± 5°	2°
VWD	± 5°	2°

7.2.2 Radiation CTS Audit

At sites which run SR and UVR, the QAS will set up a collocated radiation unit of the same make and model and run it for approximately one week. After the audit is completed, the data is collected and compared. The comparison is based on taking the average difference between values that are above zero. The comparison should agree within ±5%. Failure to meet the limits will result in screening the data for potential outliers, resolve potential issues with the field or QA unit, and overall review of data collected at the site, before, during, and after the audit. Any issues with the results may require a QA qualifier or null data qualifier, the field unit needing maintenance/calibration, or additional audit checks.

7.3 Siting

Siting of meteorological equipment for the required measurements is specific to each instrument type. Proper siting is part of the total quality control program. Of course, as in many other monitoring activities, the ideal site may not be attainable. If it is impossible to find sites that meet all of the siting criteria, compromises will be made. The important thing to realize is that the data will be compromised, but not necessarily in a random way**.** The primary objective of meteorological siting is to place the instrument where it can make precise measurements that are representative of the atmosphere in that area. The QAS performs a site evaluation once a site is established, on a three year cycle, and if changes are made to the site. Documentation includes sensor heights, any obstructions, photographs of the site, and if needed a written description outlining any potential interferences on the sensors. Listed below are specific siting requirements for meteorological equipment.

7.3.1 Wind Speed and Direction

The standard height of wind sensors over level, open terrain is 10.0 meters above ground level. If other sensor heights are used, they will be documented accurately in the ANP and AQS. Open terrain is defined as an area where the distance between the sensor and any obstruction is at least 10 times the height of that obstruction. An obstruction may be man-made (such as a building) or natural (such as a tree). If the sensor is on a boom, the boom must be twice as long as the tower's diameter and directed into the prevailing wind. If the sensor is mounted up on a tower, the tower must be of open grid design. Sensors mounted on top of a tower will be at least one tower diameter/diagonal above the top of the tower structure. Sensors on a boom will be securely mounted so that they will not twist, rotate, or sway.

7.3.2 Outdoor Temperature and Relative Humidity

The standard height is 2.0 meters above the ground. In locations where this is not possible, the sensor will be placed at approximately 10 meters, such as on top of an open grid design tower where the wind sensor is located. For the sensors at 2.0 meters, the ground beneath the sensor must be non-watered short grass or natural earth, level ground, have an area at least 9.0 meters in diameter, and should be a minimum of 30 meters from large paved areas. For all sensor heights, large industrial heat sources, roof tops, steep slopes, hollows, high vegetation, swamps, snow drifts, standing water, and air exhausts are avoided. If the sensor is mounted on a boom, the boom must be as long as the tower's diameter or diagonal distance. Sensors will have either a downward facing aspirated shield or one that points to true north. The distance between the sensor and any obstruction, man-made (e.g., a building) or natural (e.g. a tree), must be at least 4 times the height of the obstruction.

7.3.3 Barometric Pressure

The sensor will be located in a ventilated shelter about 2 meters above ground level. Care is taken to not expose the pressure sensor to anything that could interfere with the measurements. The sensor is sensitive to both the atmospheric pressure (weight above the station) and wind pressure.

7.3.4 Precipitation

The mouth of the gauge must be mounted horizontally at a minimum of 30 centimeters above ground. It is positioned in a location to avoid water splashing, being covered by snow, or anything overhead that could obstruct precipitation from going into the gauge. In addition, the collector will be heated to properly measure frozen precipitation. If located at ground level, the surface area around the gauge must be natural vegetation or gravel. The gauge must be positioned at least 2 times the height of any obstruction. If placed in an open area, a wind shield should be used.

7.3.5 Solar Radiation and Ultraviolet Radiation

The sensor will have an unrestricted view of the sky in all directions. Locations where there are obstructions that could cast a shadow or reflect light on the sensor, such as light-colored walls or artificial sources of radiation, are avoided. The elevation to the horizon as viewed from the pyranometer must not exceed 5 degrees. Sensor height is not critical for pyranometers; consequently, tall platforms or roof tops are typical locations.

7.3.6 Mixing Layer Height

The ceilometer for determining MLH measurements is intended for more macro-scale application than are the surface meteorological measurements. Consequently, the location of the ceilometer need not be associated with any particular PAMS surface site. Factors that will be considered in selecting a site for the MLH monitor include whether the upper-air measurement for the proposed location are likely to provide the necessary data to characterize the meteorological conditions associated with high ozone concentrations, and the extent to which data for the proposed location of the ceilometer may augment an existing upper-air network. The ceilometer must be installed on a level concrete pad or wooden platform suitably located to provide an unobstructed view of the sky. A wide-open location is recommended where there are no tall trees, overhead lines, or antennas nearby. Proximity to powerful radars should also be avoided. Any object in the cone projecting upward created by an angle of 25° from vertical will impede the ability of the ceilometer to properly measure atmospheric backscatter. Common interfering objects would include powerlines, tree branches, tower support guidewires, flagpoles, or similar features which may permanently or transiently present above the ceilometer.

Section 8: Training

Formal staff training is scheduled to train new employees and periodically update employees' skills and program operations. Formal staff training is coordinated with the Section Chiefs, senior level staff, or parameter specialists of the AMS, QAS, and ATS of the AMB on an as needed basis for those person(s) engaged in the following: operating, calibrating, verifying, validating, and auditing analyzers/samplers; laboratory procedures; field duties; safety; and any other items related to work performed by staff in the AMB. The training for staff is tracked and documented by the individual section chiefs, except for any in-house training pertaining to computer safety, which is documented by the IDEM computer staff but able to be tracked by individual section chiefs. Standard literature references are readily available to all staff members including the Federal Register, manufacturer's instrument manuals, and quality assurance guideline documents related to the program objectives. Courses and other training are also provided through U.S. EPA and vendors.

Section 9: Documentation and Records

The goal of IDEM is to collect data that is accurate and representative of the actual conditions. For this to occur, documentation and record keeping have to be performed at a high level of accuracy and be consistent amongst all participants who are part of the PQAO. Table 9 summarizes what documentation is involved, how it is handled, and how records are maintained.

Table 9. Documentation and Records

Document	Location	Retention Time	Custodian
ANP; 5 Year Network Plan; QAPP	IDEM internet and extranet; AMB shared drive	Latest on IDEM internet and extranet; AMB shared drive maintains previous versions	ANP and 5 Year Network Plan – AMS (1 and 2) Chief(s); QAPP – QAS Chief
TSOPs/SOPs	IDEM extranet; AMB shared drive	Latest on extranet; AMB shared drive maintains previous TSOPs/SOPs	QAS Program Coordinator and OPS
Logs	Log on site computer hard drive; electronic log available through LEADS	Indefinitely	AMS Environmental Manager LEADS Administrator
AMS Calibration Forms	AMB shared drive	Indefinitely	AMS Parameter Specialist

Document	Location	Retention Time	Custodian
QAS Audit Forms	AMB shared drive	Kept indefinitely	QAS Environmental Manager
QAS data memos; data checks; and site evaluations	AMB shared drive; VFC; site evaluation record also on LEADS	Kept indefinitely	QAS Chief and Program Coordinator
Calibrations, Certifications, and Verifications performed by the QA laboratory	AMB shared drive	Information kept at least 3 years unless item is still in circulation then information is kept indefinitely	QA Laboratory Manager
NIST-traceable Certifications	QA Laboratory Cabinet File	Kept Indefinitely	QA Laboratory Manager

Section 10: Network Description (or Sampling Process Design)

Meteorological monitoring is primarily conducted based on needs for specific weather patterns that can play a role on pollutant concentrations. The IDEM ANP provides information on sites and can be found at https://www.in.gov/idem/airquality/2389.htm

Network design and sampler siting is established based on 40 CFR Part 58 Appendices D and E, U.S. EPA GD's, and is mentioned in Sections 6 and 7 of this QAPP.

Section 11: Sampling Method Requirements

Sampling equipment and procedures for meteorological parameters follow "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements". Specific instructions on technical aspects of these procedures can be found in the AMB TSOPs/SOPs mentioned in this QAPP and the equipment's manual. The AMB maintains a complete set of TSOPs/SOPs for all procedures, which is available through the AMB shared computer drive and the IDEM website, https://extranet.idem.in.gov/main.php?section=standards&page=sops.

11.1 Meteorological Equipment

IDEM utilizes meteorological equipment that meets accuracy requirements and is able to function for long periods of time with minimal maintenance (see Table 10).

Table 10. Meteorological Equipment

Parameter	Meteorological Monitoring Equipment
WS	RM Young model 05305-AQ RM Young model 81000 RM Young model 86004

Parameter	Meteorological Monitoring Equipment
WD	RM Young model 05305-AQ RM Young model 81000 RM Young model 86004
VWD	RM Young model 81000
OT	RM Young model 41372VF
RH	RM Young model 41372VF
BP	Novalynx model 230-601V Novalynx model 230-701 V-5 RM Young model 61202V RM Young model 61302V
SR	Eppley model PSP
UVR	Eppley model TUVR
P	RM Young model 52202-E
MLH	Vaisala Model CL51

11.2 Monitoring Procedures

- WS – A Propeller unit measures the WS based on the revolutions per minute of the propeller. The ultrasonic wind unit operates on the principle that the time required for a sound wave to travel from point A to point B is affected by the speed of the wind in a predictable and repeatable way.
- WD – A Propeller unit measures the WD based on the direction the unit is facing. The wind will move the unit by exerting a force on the tail of the unit. The ultrasonic wind unit operates on the principle that a transducer sends a pulse of ultrasonic sound from the north facing side of the sensor.
- VWD – An ultrasonic anemometer, which is a 3-axis, no-moving-parts wind sensor, is used for requiring fast response, high resolution and three-dimensional wind measurement.
- OT – Combination OT/RH probe using platinum RTD located inside a ventilated shield.
- RH – Combination OT/RH probe using Vaisala intercap hygrometer located inside a ventilated shield.
- BP – A BP sensor measures absolute atmospheric pressure and converts it into a linear, proportional voltage, using digital computer technology.
- SR – A Precision Spectral Pyranometer is used to measure the solar radiation, which is the total electromagnetic radiation emitted by the sun which is received at our monitoring site. These values are expressed in Langleys per minute. A Langley is a unit of energy per unit area (1 gram-calorie/cm^2) commonly employed in radiation measurements.
- UVR – A Total Ultraviolet Radiometer is used for the measurement of solar UV radiation. This instrument utilizes a photoelectric cell protected by a quartz window. A specially designed teflon diffuser not only reduces the radiant flux to acceptable levels but also provides close adherence to the Lambert cosine law. An encapsulated narrow bandpass

(interference) filter limits the spectral response of the photocell to the wavelength interval 0.295-.0385 µm.

- P – A tipping bucket is used for the measurement of precipitation. The tipping bucket consists of a funnel that collects and channels the precipitation into a small seesaw-like container. After a pre-set amount of precipitation falls, the lever tips, dumping the collected water and sending an electrical signal. The tipping bucket is heated so that ice or snow will melt and be reported as rainfall.
- MLH – A Ceilometer is designed to measure high-range cirrus cloud heights without surpassing the low and middle layer clouds, or vertical visibility in harsh conditions. It´s backscatter profiling over full range is up to 15 km (49,200 ft.).

11.3 Failed Data Events

In the event of malfunctioning equipment that was not collecting data according to specific requirements, the AMS will document the failure onto the LEADS log, giving detailed information on the condition of the equipment and its effect on the data. If the QAS finds an issue, a detailed log is entered in LEADS and a memo will be sent to the AMS, who will then confirm the results. Refer to the appropriate AMB TSOP's/SOP's for further information.

Section 12: Sample Handling and Custody

12.1 Sample Handling

Measurements of all the continuous meteorological parameters are collected year round. All meteorological equipment digital outputs are connected to a data logger. This data is downloaded every 10 minutes via broadband by LEADS. LEADS ingests, integrates, processes, preliminarily quality controls, stores, and provides visualization of the data. The data is provided to the public within one hour of collection. The data goes through extensive quality control analysis then it is provided to the QAS, which does its own post processing checks. Data is uploaded into AQS within 90 days after the end of each quarter. Certification of all data for the previous calendar year is completed by May of the current year.

12.2 Sample Custody

The AMB strives to collect high quality data that is accurate, defensible, and representative of an area's ambient air. Data integrity is maintained in two ways. First, the security of the air monitoring site helps to ensure that the equipment is not tampered with which would compromise the data. Sites are either located in a dedicated shelter in a locked fenced area or if in a building, in a locked room with limited access. Data loggers including laptop computers require a password to gain access. Secondly, all of the sites maintain either a paper log book or an electronic log book. Any staff who visits the site for any reason is to state the purpose of their visit and leave information detailing the work performed at the site. Log entries also are entered on templates, which ensures consistency.

12.3 Photographs and Digital Still Images

When photographs or digital images are taken with either a cell phone or the AMB digital camera for purposes of documenting and to support a field investigation, a record of each exposure or image will be saved as a file on an AMB shared drive on the computer. The following information will be recorded:

- The site name and what it shows will be part of the file's name, which will be stored based on the year it was taken. For example, file name "Gary IITRI SE" stored under the path QA\Site Information\Site Photos\Gary IITRI\2020.
- The name of the individual who took the photograph or digital image will correspond to any paperwork, such as a site's evaluation. If no paperwork is used, a log entry on LEADS is adequate.

12.4 Equipment Documentation

Any equipment used in the meteorological program to perform calibrations, verifications, and audits will have documentation kept on it. A certification file will be kept for each item and stored in the QA laboratory and on the AMB shared drive.

Section 13: Analytical Methods

Analysis at a laboratory is not required because the monitoring method employed analyzes samples in situ.

Section 14: Quality Control Requirements

Field sampling quality control and acceptance criteria is detailed in Section 7.1 of this QAPP. Table 11 lists the action to take when results do not meet measured quality objectives.

Table 11. Measured Quality Objective Checks and Outcomes

Check	Outcome
AMS Calibration Frequency	If more than 13 months have passed, data may be assigned a QA qualifier "1" pending verifications and other checks indicating condition of data. If additional checks are not available, data is invalid from 13 months after the calibration until a new calibration is performed. Data is replaced with an "EC" null data qualifier.
AMS Verification Frequency	If a verification is missed, data will be assigned a QA qualifier "1" if other checks indicate accurate data. Any indication of an issue may invalidate data starting from the last passed verification up to a new passing verification.
AMS Calibration and Verification Results	If a verification check fails, further review of the data and the condition of the meteorological equipment may result in either a null data qualifier or a QA Qualifier on the data or void the verification check. Limits must be met after a calibration for valid data collection to occur.
QAS PE Audit Frequency	Any audit that deviates from an assigned check will be made up prior to any AMS calibration.

Check	Outcome
QAS PE Audit Results	If audit results don't meet specification, data is suspect. The AMS must follow up with a verification, and if needed a calibration. Data may be flagged depending on AMS findings. Discrepancies between AMS and QAS findings may require a repeat of the audit. To come into agreement the QAS may need to observe the AMS verification.

Section 15: Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Meteorological equipment must have checks and routine preventive maintenance performed to ensure proper operation. These checks are performed by AMS on a routine schedule. Most manufacturers supply a preventive maintenance checklist with the instruction manual. A specific schedule, similar to that shown in Table 12, should be maintained. All checks and maintenance must be documented in LEADS. The AMS parameter specialist is informed of any issues.

Table 12. Checks and Preventive Maintenance

Item	Inspection Frequency	Action Required	Action if Item Fails Inspection
OT/RH Blower	During site check which is performed approximately every 3 weeks	Determine if blower is working	Data invalid back to last passing site check unless data review determines otherwise
P	During site check which is performed approximately every 3 weeks	Clean funnel	If clogged, data invalid back to last passing check unless data review determines otherwise
SR/UVR	During site check which is performed approximately every 3 weeks	Make sure sensors are level; check silica gel; make sure no dirt or debris on top of units	Level units; change silica gel; clean top of units; determine if data is accurate or needs a QA Qualifier or a Null Data Qualifier back to last passing check
SR	During site check which is performed approximately every 3 weeks	Determine if blower is working	Data suspect back to last passing check unless data review determines otherwise

Section 16: Instrument Calibration and Frequency

All meteorological equipment in the air monitoring network adheres to the prescribed calibration schedules that are defined in the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements" and the AMB TSOPs/SOPs, which are mentioned throughout this QAPP. Transfer standards used for this work also follow strict verification/audit/certification/calibration schedules, as required by the documents mentioned. Almost all transfer standards are verified/certified/calibrated against standards that are maintained at the QA laboratory. If the QA laboratory cannot do the work, then the item is sent to a standards laboratory. On occasion some items are sent to a standards laboratory to cross check the transfer standards used in the QA laboratory. All equipment is verified/certified/calibrated prior to use. Table 13 lists the transfer standards used in the meteorological program.

Table 13. Instrument Calibration and Frequency

Type of Device	Frequency	Primary Standard	Limit
Anemometer Drive or Synchronous Wind Motor	12 months	QAS NIST-Traceable Photo Tachometer	≤±1.0 RPM
Barometer	12 months	QAS Primary Standard Mercury Barometer	≤±1.0 millibar
Relative Humidity Sensor	12 months	QAS Factory Certified NIST-Traceable Transfer Standard	≤±3.0 %RH
Isotech/Temperature Probe	12 months	QAS Primary Standard Temperature Device	≤± 0.5 °C ; ≤± 0.2 °C if used for OT Meteorology Program Calibrations, Verifications, and Audits
SR for QAS Audits	2 Years	Factory NIST-Traceable Standard	Factory limits determined by manufacturer
UVR for QAS Audits	2 Years	Factory NIST-Traceable Standard	Factory limits determined by manufacturer
Photo Tachometer	12 months	Factory NIST-Traceable Standard	Factory limits determined by manufacturer

Section 17: Inspection/Acceptance Requirements for Supplies and Consumables

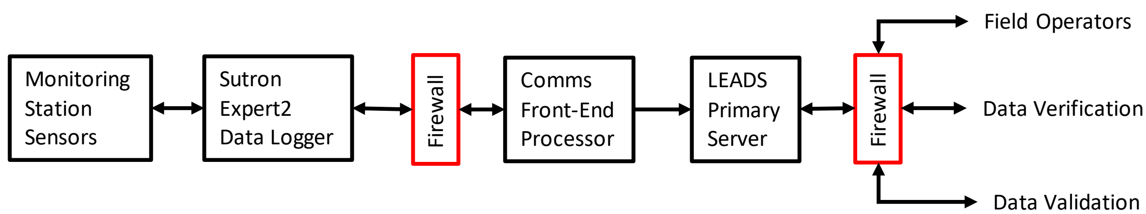
Meteorological replacement parts are obtained from the manufacturer or a distributor when the items are commonly available and needed by the AMB. The parameter specialist for the AMS and the ATS keeps track of their own supplies and will order items when needed. The QA laboratory manager makes sure the QA laboratory has enough supplies and QA field staff also keep track of when items are needed. A designated QA environmental manager will order supplies for the QAS when needed. Most consumables do not have an expiration date. If there is an expiration date the AMS and ATS parameters specialist and the QA laboratory manager will track and dispose of it when it expires.

Section 18: Non-direct Measurements

All IDEM meteorological data is produced directly from the IDEM owned NIST-traceable equipment. Some site selection and data analysis can be based upon meteorological data generated by other entities, such as the National Weather Service, as well as traffic counts by INDOT. The additional data used for site selection and data analysis is viewed as being accurate since this data falls under specific rules and guidelines.

Section 19: Data Management

Minimizing data loss is of paramount importance to each monitoring program in order to meet and exceed the program's data completeness requirements. Data loss can result from missing or invalid data. Data records are generated through the use of LEADS. It is the goal of IDEM to collect 100% of generated data and maintain a completeness rate of at least 75% valid data. The U.S. EPA requires at least 75% of data to be valid to meet completeness requirements. The processes of determining valid data and the QC/QA of these processes is mentioned in this QAPP. The data process includes collecting, storing, transmitting, verifying, validating, and reporting to the U.S. EPA's AQS database.



The data process starting from the field to AQS submittal consists of the following steps:

1. Data collection is performed using meteorological instrumentation of known accuracy and precision.
2. Data is sent from the instrument via digital or analog output to data logger. Although data collection is continuous, data is stored in five minute averages. The data logger is capable of storing approximately two months of data before it starts being overwritten. The site data loggers require a password to access it.
3. The LEADS server in Round Rock, Texas communicates with the data loggers and retrieves data and operator logs every 10 minutes through the internet via cellular modem. The LEADS software collects data from the data logger using the Native Datalogger Computer-To-Computer language (CC-SAIL).
4. The data is checked for errors, processed and stored in a database. The LEADS database uses a flat, packed binary structure and are physically segregated by date and monitoring site. Each binary data file contains all the measurements from a monitoring site for a specific day. The binary data files are kept indefinitely on the LEADS server. There is a mirrored backed up of the LEADS server on a second server in Colorado. The original data files can also be reloaded if a needed, such as accidental deletion of processed numbers or bogus slope, intercept, offset applied to data.
5. Each business day, the AMS LEADS Administrator will check the monitoring data

database to ensure that all data were polled and transmitted successfully from each monitoring station and stored on LEADS. In case of missing data, troubleshooting of the communication system will be conducted to determine the problem. Once communications with the monitoring site is restored the data will be backfilled on the LEADS server.

6. Approximately 1 to 3 weeks after the end of a month, AMS staff will initiate the data verification procedure. AMS staff log into the LEADS server and are able to review and flag raw data and document data verification by using a program within LEADS called ManVal. (Note: LEADS recognizes this process as “data validation” although it is the verification process). ManVal requires a validator log to complete the validation of the data which documents who verified the data, changes made, and a date/time when this occurred (see AMB TSOPs “Meteorological Parameters Data Validation”).
7. Once the data has been verified, AMS staff will inform the QAS program coordinator via e-mail that verified data is ready for validation.
8. The QAS program coordinator logs the date that the verified data has been sent to the QAS and then informs QAS environmental manager via e-mail that data is ready for validation. The QAS environmental manager has 15 business days to complete the validation process.
9. The QAS environmental manager logs into the LEADS server (read access only) and performs an audit on the data (validation process) using the various LEADS reports and the ManVal program (see LEADS Validated Data Review Procedures”). The validation process is documented on a Validation Check form, which is stored on the Branch shared drive.
10. If data issues arise during the validation process, the issues are sent to the appropriate AMS staff member for correction or additional information. Any data corrects will be noted in the validator logs.
11. Once the validation review is complete, the QAS environmental manager will initial and date the Validation Check form. The QAS environmental manager informs the QAS program coordinator via e-mail that the data validation is complete.
12. The QAS program coordinator will log the data validation completion date and informs the AMS AQS administrator via email that the data review process is completed by the QAS.
13. The AMS AQS administrator generates an AQS report on the LEADS server. The AQS report is reviewed for accuracy and submits to AQS.
14. Each year data from the previous year is certified as being true and accurate. The AMB chief, AMS (1 and 2) chiefs, TAS chief, QAS chief, and specific staff in the AMS (1 and 2) and QAS do a final check on this data package, which is then submitted to U.S. EPA.

Annually, the AMS will verify each data logger’s voltage which uses analog against an NIST certified power supply. For parameters collected digitally, 25% of those parameters have the raw data from the data logger compared with the five minute data stored internally in the analyzer along with the LEADS five minute and hourly data. Both of these procedures help ensure an accurate collection of data by testing the acceptability of the hardware and software configurations.

Quarterly verified and validated data is submitted to the AQS within 90 days after the quarter is complete. Ambient data is made available to the IDEM website as it is being collected; therefore the data has not initially had QC or QA checks performed. Data is also provided to AIRNOW as it is being collected.

Data generated by the AMS(s) during verifications/calibrations and by QAS during audits is entered into an excel file then stored on a shared computer drive.

Section 20: Assessments and Response Actions

IDEM utilizes several assessment procedures to identify and correct issues. The corrective action process may include formal or informal communication and response (see Table 14).

Table 14. Assessments and Response Actions

Assessment	Conducted By	Frequency	Goals
Verification/Calibration	AMS Personnel	Annual or 6 months	QAPP Requirements
PE Audit	QAS Personnel	Annual or 6 months	QAPP Requirements
Data Verification	AMS	Monthly	Screening of data, chart trace, QC checks
Data Validation	QAS	Monthly	Screening of data, chart trace, QC and QA checks
QAPP	QAS	Annually	Determine if changes are needed which accurately describes the project
ANP	AMB	Annually	Determine if sites cover necessary air monitoring requirements
Annual Data Certification	AMB	Annual	Review data for issues
Siting	QAS	3 years per site	QAPP Requirements
5 Year Network Assessment	AMB	5 years	Determine future monitoring needs and site locations
Technical Systems Audit	EPA Regional Personnel	Once every 3 years	CFR Requirements

In the event that an assessment identifies an area of concern, there are specific corrective actions which occur depending on what the finding shows. Below is listed the assessment and corrective action time frame for follow-up.

Verification/Calibration – The AMS LEADS Administrator will review data generated from the sites on a daily basis. The parameter specialist will also review the data several times a week. The AMS addresses issues once they are aware. Verifications/calibrations are performed on a six month or annual basis or when there is evidence of data issues. QAS environmental manager ensures action was taken and issues were resolved.

PE Audit – The QAS is set up as an independent section within the AMB and as such performs internal PE audits using equipment that are independent of equipment used by the AMS. PE audits are scheduled by a QAS environmental manager on a six month or annual basis. QAS staff members notify the AMS parameter specialist of any issues either from site or once back in the office with written notification (memorandum or e-mail) following soon after. Once the issue is resolved, the AMS parameter specialist must document the issue resolution.

Data Verification Process – The AMS parameter specialist performs a verification of the ambient data within 1 to 3 weeks after the end of a month. Documentation of the process can be found in the LEADS validator notes.

Data Validation Process – A QAS staff member performs a validation review of the data within 15 working days after the QA Program Coordinator is informed that a data package is available for review. Data validation is documented on the Data Check Sheet, which are stored on the AMB shared drive.

QAPP – QAS section chief ensures QAPP is being followed and makes necessary changes, with approval by AMB chief, AMS (1 and 2) chiefs, and ATS chief. An annual check is documented or when a change needs to be made.

ANP – The Annual Network Plan is due to the U.S. EPA Regional Administrator by July 1st. The AMB tries to have a complete ANP available for public comment by mid-May to allow for the 30-day public comment period to be completed by mid-June. Corrective actions taken immediately (based on issue could be one day but prior to New Year) by AMB based on U.S. EPA feedback.

Annual Data Certification – The Annual Data Certification for ambient data from the previous year (January 1 – December 31) is due to the U.S. EPA Regional Administrator by May 1st of each year. The AMB reviews the annual data package and resolves any correctable issues, if practical, prior to submission of the certification package.

Siting – The QAS performs site evaluations on a 3-year cycle from the previous site evaluation. The AMS addresses issues based on QAS findings (usually within a work day if data is impacted or some time frames may be extended based on the nature of the issue and if the site is on private property). QAS chief ensures corrective action is taken to resolve the issues.

5 Year Network Assessment – The 5-year Network Assessment is due at U.S. EPA by July 1st for years ending in zero or five. Corrective actions by AMB based on U.S. EPA feedback within the time frame allotted for the response.

Technical Systems Audit – Technical System Audits are scheduled by the U.S. EPA Regions on a 3-year frequency. The QAS works with AMS(s) and ATS to address any audit findings. All findings should be resolved within 1 year of the TSA report.

Section 21: Reports to Management

Reports that are generated and utilized in the meteorological program are listed in Table 15.

Table 15. Reports to Management

Report	Frequency	Responsible Party
QA Audit Findings	As needed	QAS
Invalid Data Memos	As needed	AMB
Annual Network Plan	Annual	AMB
5 Year Network Plan	5 Years	AMB

Section 22: Data Validation and Usability

Many of the criteria used to review and validate data have been detailed in the previous sections of this QAPP. The AMB utilizes the established QAPP, TSOPs/SOPs, and U.S. EPA document "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements", to determine data validity.

Section 23: Validation and Verification Methods

Data verification is the process of evaluating the completeness, correctness and conformance of a specific data set against the method, procedural or contractual requirements, as specified in both the TSOPs/SOPs and 40 CFR Part 58. Data validation is a process that extends the evaluation of data beyond method, procedural or contractual compliance (i.e. data verification) to ensure that reported values meet the quality goals of the environmental data operations and that the data can be used for its intended purpose.

The AMB uses the meteorological validation templates provided in the U.S. EPA QA Handbook for Air Pollution Measurement Systems: Volume IV: Meteorological Measurements (EPA-454/B-08-002, March 2008) as well as manufacturers of the meteorological equipment for the handling of the meteorological data and the weight of evidence approach for validating meteorological data. The grading of the meteorological data is similar to how the pollutant data is handled. The handling of the pollutant data is as follows:

- Critical criteria are issues deemed critical to maintaining the integrity of the hourly ambient concentration measurement or a group of successive hourly ambient concentration measurements. Data reviewers should invalidate observations that do not meet each and every criterion in the critical criteria table unless there are compelling reasons and justification for not doing so. Basically, the hourly measurement or group of hourly measurements that do not meet one or more of these criteria is invalid unless proven otherwise. In most cases, the CFR dictates the requirement, the implementation frequency of the criteria and the acceptance criteria so these criteria are considered regulatory in nature.

- Operational criteria are situations where violations of a criterion or criteria may be cause for invalidation of the data. Data reviewers should consider other QC information that may or may not indicate the data are acceptable for the parameter they want to control. Therefore, ambient data, which do not meet one or more of these criteria, are suspect unless other QC information demonstrates otherwise and the reviewers have adequate documentation of that information. Data reviewers should investigate, mitigate or justify the reason for not meeting the criteria.
- Systematic criteria include those criteria, including the DQOs, which are important for the correct interpretation of the data, but do not usually impact the validity of the ambient data. If the data do not meet the DQOs, this does not invalidate any of the hourly measurements, but it may impact the confidence in the attainment/non-attainment decision.

The AMB brackets all meteorological data using the results of verification checks, calibrations, or performance evaluation audits to ensure the meteorological equipment was in proper operating condition between the checks. When equipment fails a check, the operator can program LEADS software to flag the data as LIM from the last passing check to time & date when the issue causing failure is remedied. The LEADS program is also able to flag data automatically based on the criteria established in the program, such as extreme outdoor temperature change from one hour to the next. The AMS parameter specialist will review the data, determine the cause for the failure and verify the extent of the data invalidation period. During the validation process, the QAS will review the invalid data period to ensure it is proper, accurate, and documented.

23.1 LEADS Data Review

The LEADS software acquires 5-minutes concentration averages from the instantaneous concentrations generated by the meteorological equipment. As data is being collected in LEADS, there are several automatic checks that the LEADS software performs, such as no changes in data for several hours, extreme values, and stability issues. Dramatic shifts in data can also be recognized by LEADS, which will then flag the data until the AMS parameter specialist can do a further review. Depending on the outcome of the automatic tests, LEADS may initially flag the check as PASSED, WARNING, FAILED, INVALID, or INCOMPLETE (See LEADS Manual for information on the types of automatic tests and the check results). A FAILED check will result in flagging affected data with a LEADS LIM code. LEADS will flag missing data with the LEADS LOST code if it cannot repoll the data logger to download the missing data.

23.2 AMS Verification

The LEADS administrator reviews the LEADS reports every business day to check for anomalies and to repoll data loggers when missing data is notated. In addition the LEADS administrator will review any FAILED check and notify the AMS parameter specialist of the issue.

After a month of data is collected, a monthly report is generated by LEADS. The AMS verifies all data during the monthly data review per the AMB TSOPs “Meteorological Parameters Data Validation”. The monthly report is reviewed by the AMS parameter specialist for data values as well as any flags applied by LEADS. These are reviewed using the LEADS operator to justify the application of the flag and to determine if they are accurately applied. The data trace is also evaluated. Any changes needed are applied by the AMS parameter specialist. Once this process is completed the AMS parameter specialist leaves a “Validator Note” in LEADS, which means the data has been verified. Once the verification process is completed by the AMS, the QAS program coordinator is informed by the AMS parameter specialist that the data is ready for QA.

The following null and data qualifiers are available in LEADS to flag data as appropriate:

Flag Text	Description	EPA Qualifier	
		Null Data	Data Qualifier
ZERO	Neg Value Detected - Zero Reported		9
AMB-A	High Winds		A
AMB-B	Stratospheric Ozone Intrusion		B
AMB-C	Volcanic Eruption		C
AMB-D	Sandblasting		D
AMB-E	Forest Fire		E
AMB-F	Structural Fire		F
AMB-G	High Pollen Count		G
AMB-H	Chemical Spill or Industrial Accident		H
AMB-I	Unusual Traffic Congestion		I
AMB-J	Construction/Demolition		J
AMB-K	Agricultural Tilling		K
AMB-L	Highway Construction		L
AMB-M	Rerouting of Traffic		M
AMB-N	Sanding/Salting of Streets		N
AMB-O	Infrequent Large Gatherings		O
AMB-P	Roofing Operations		P
AMB-R	Cleanup After Major Disaster		R

n	Not used	AA	
TEMP	Shelter Temperature Outside Limits - 9971 - AE	AE	
FEW	Insufficient Data - 9975 - AI	AI	
VOID	Voided by Operator - 9978 - AL	AL	
NEG	Failed NEG Test - 9979 - AM	AM	
MUL	Failed MUL Test - 9979 - AM	AM	
BLAN	Blank Sample	AM	
AUDI	Audit Sample	AM	
5PPB	5 ppb-V Unblended Standard Check	AM	
EXP	Experimental or Bad Sample	AM	
RT S	Standard Sample	AM	
ARC	GC Acetylene Response Check	AM	
CACS	GC Compress Air Comp Sample	AM	
DCSD	GC Daily Cal Check Stand Dup	AM	
DLA	GC Detection Limit Analysis	AM	
RAS	GC Radian Audit Sample	AM	
UNK	GC Unknown Flag in File	AM	
NOD	Not Detected	AM	
LIM	Failed Limit Check - 9980 - AN	AN	
MAL	Machine Malfunction - 9980 - AN	AN	
ICE	Bad Weather - 9981 - AO	AO	
LOST	Lost - 9983 - AQ	AQ	
POOR	Poor Quality Assurance Results - 9985 - AS	AS	
ADJ	Instrument Adjustment - Cal - Background Zero - 9986- AT	AT	
NOL	Not On Line - 9987 - AU	AU	
POW	Power Failure - 9988 - AV	AV	
SPZ	Span-Zero Check - 9991 - AY	AY	
VER	QC Verification - 9992 - AZ	AZ	
PM	Preventive Maintenance - 9993 - BA	BA	
CAL	Multi-Point Calibration - 9995 - BC	BC	
SPN	Span Check - 9998 - BF	BF	
OPE	Operator Error - 9963 - BJ	BJ	
DAS	Data Logger not communicating with instrument - 9962 - BK	BK	
QAS	QA Audit in Progress - 9961 - BL	BL	
BAL	Negative values under AQS Acceptable Limits - BR	BR	

ALNR	Above Linear Range - EH		EH
AMB-IF	Fire - Canadian Informational - IF		IF
AMB-IH	Fireworks Informational - IH		IH
AMB-IM	Prescribed Burning - IM		IM
AMB-IT	Wildfires - US		IT
BDL	Below Detection Limit		MD
AMB-RH	Fireworks RH		RH

Additional flags are available to be applied as well. These can be found at https://aqs.epa.gov/aqsweb/documents/codetables/qualifiers.html.

23.3 QAS Validation

The QAS validates the data per the following AMB TSOP “Leading Environmental Analysis and Display System (LEADS) Validated Data Review Procedures”. The QAS program coordinator sends an e-mail to the QAS staff member who is responsible for performing the validation on that specific data. A standard form is used by QAS, which includes analysis of data values as well as a review of QC and QA processes and to document the review. The QAS has the authority to have data rechecked and if needed, invalidating additional data.

Section 24: Reconciliation with Data Quality Objectives

The data quality objectives and intended uses for the meteorological data are discussed in Section 7 of this QAPP. The main purpose of this data is to support pollution data which is being collected to show compliance with the U.S. EPA NAAQS and to measure air pollutant concentrations that may be of concern for public health concerns and public welfare considerations. Section 7 of this QAPP also lists the measurement quality objectives, which were established to provide the expected data quality that users need.

It is the role of the QAPP to establish procedures to control measurement uncertainty to an appropriate level in order to achieve the objectives for which monitoring data are collected. As long as guidelines and any TSOPs/SOPs governing the measurement process are followed and all measurement quality objectives listed in this QAPP are met, it will be recognized that the DQOs can be achieved. However, there is always a chance that exceptional field events may negatively affect the performance of the monitoring station. Therefore, it is important to reconcile the monitoring data with the DQOs to evaluate whether the data set is adequate for its intended use. This involves reviewing routine data, such as the monthly verification and validation reviews described in section 23 of this QAPP, and the results of verification checks. Unacceptable performance for any of the DQO goals does not automatically indicate that the data set cannot be used for its intended purpose, i.e. the support of the decision process for a NAAQS. However, the impact on the confidence with which the data set can be used for its intended purpose in the decision process will have to be reviewed and communicated. This is done in the quarterly reports generated by the QAS environmental manager and QAS chief. Any anomalies are reported to the AMS(s) and ATS section chiefs and the AMB chief. The reports will identify the point(s) the data failed to meet DQOs and at what point in time, after corrective action, the data again meets DQOs. The corresponding data will be flagged and commented, and all supporting documentation will be included in the report.

The performance of the monitoring network for the previous year's data (January 1 to December 31) is evaluated for the annual Data Certification Package, which is due to the U.S. EPA by May 1st. The AQS AMP600 Report, Certification Report, is used to evaluate the performance of the network as to its attaining the Data Quality Objectives. The AMP600 report provides summary statistics on QA/QC activities and on collected data from each monitor. This report also provides a summary evaluation of monitoring network performance by flagging data collection and QA/QC activities as acceptable/green, warning/yellow or recommend N/red. Normally by this time any issues or concerns have already been dealt with and sufficient documentation is available. The annual certification letter will provide a short summary to document data collection or QA/QC activities flagged as warning (yellow) or red (recommend N).